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P2 1297393

THE UNITED STATES OF AMERICA

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

April 19, 2005

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APPLICATION NUMBER: *PCT/US04/23133*
FILING DATE: *July 19, 2004*
RELATED PCT APPLICATION NUMBER: *PCT/US05/06898*

By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

N. WILLIAMS
Certifying Officer

PCT/US04/23133

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REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

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International Application No. PCT/US 04/23133

International Filing Date (19.07.04) 19 JUL 2004

Name of receiving Office and "PCT International Application" APPLICATION RO/US

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 138/6PCT

Box No. I TITLE OF INVENTION

SYSTEM AND METHOD FOR ELECTRONICALLY IDENTIFYING VEHICLE WHEELS ON-THE-FLY DURING MANUFACTURE

Box No. II APPLICANT ☒ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

SMYTH, Larry C.
16108 River Point Drive
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US

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Facsimile No.

Teleprinter No.

Applicant's registration No. with the Office

State *(that is, country)* of nationality: CA

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☒ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
☐ applicant only
☐ applicant and inventor
☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

Schwartz, Jeffrey J.
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US

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Facsimile No. 704/552-1866

Teleprinter No.

Agent's registration No. with the Office 37,532

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

See Notes to the request form

Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a), the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

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(The check-boxes above may be used to exclude (irrevocably) the designations concerned in order to avoid the ceasing of the effect, under the national law, of an earlier national application from which priority is claimed. See the Notes to Box No. V as to the consequences of such national law provisions in these and certain other States.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1) (18.07.03) 18 JULY 2003 ~~07/18/2003~~	60/488,602	US		
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☐ all items ☒ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

** Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):* ....

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*:

ISA / US

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority)*:

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII DECLARATIONS

The following **declarations** are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration)*:		Number of declarations
☐ Box No. VIII (i)	Declaration as to the identity of the inventor	:
☐ Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	:
☐ Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	:
☐ Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America)	:
☐ Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	:

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application **contains:**

(a) **in paper form,** the following number of sheets:

request (including declaration sheets)	:	3
description (excluding sequence listing and/or tables related thereto)	:	14
claims	:	5
abstract	:	1
drawings	:	8
Sub-total number of sheets	:	31
sequence listing	:	
tables related thereto	:	
(for both, actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (c) below)		
Total number of sheets	:	31

(b) ☐ **only in computer readable form** (Section 801(a)(i))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

(c) ☐ **also in computer readable form** (Section 801(a)(ii))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which are contained the
- ☐ sequence listing: . . . . . :
- ☐ tables related thereto: . . . . . :

(additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item):*

		Number of items
1. ☒	fee calculation sheet	: 1
2. ☐	original separate power of attorney	:
3. ☒	original general power of attorney	: 1
4. ☐	copy of general power of attorney; reference number, if any:	:
5. ☐	statement explaining lack of signature	:
6. ☐	priority document(s) identified in Box No. VI as item(s):	:
7. ☐	translation of international application into *(language)*:	:
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9. ☐	sequence listing in computer readable form *(indicate type and number of carriers)*	
(i) ☐	copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application)	:
(ii) ☐	*(only where check-box (b)(i) or (c)(i) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Rule 13*ter*	:
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(iii) ☐	together with relevant statement as to the identity of the copy or copies with the tables mentioned in left column	:
11. ☐	other *(specify)*:	:

Figure of the drawings which should accompany the abstract: 1

Language of filing of the international application: US

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Jeffrey J. Schwartz
Agent for Applicant
US Patent Bar Reg. No. 37,532

(19.07.04)

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1. Date of actual receipt of the purported international application: DT02 Rec'd PCT/PTO 19 JUL 2004
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA / US
6. ☐ Transmittal of search copy delayed until search fee is paid

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PCT/US04/23133

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FEE CALCULATION SHEET

Annex to the Request

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International Application No. PCT/US 04/23133

Date stamp of the receiving Office (19.07.04) 19 JUL 2004

Applicant's or agent's file reference 138/6PCT

Applicant

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . 300.00 [T] — 300

2. SEARCH FEE . . . . . 1,000.00 [S] — 1000

International search to be carried out by _____

(If two or more International Searching Authorities are competent to carry out the international search, indicate the name of the Authority which is chosen to carry out the international search.)

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Where items (b) and/or (c) of Box No. IX apply, enter **Sub-total number of sheets**
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[i1] first 30 sheets . . . . . 1,134.00 [i1] — 1134

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Receiving Office: RO/ US

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Date: July 19, 2004

Name: Jeffrey J. Schwartz

Signature: [signature]

See Notes to the fee calculation sheet

PCT/US04/23139

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POWER OF ATTORNEY

(for an international application filed under the Patent Cooperation Treaty)

(PCT Rule 90.4)

The undersigned applicant(s) *(Names should be indicated as they appear in the request)*:

Smyth, Larry C.

hereby appoints (appoint) the following person as: [X] agent [ ] common representative

Name and address
(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

Schwartz, Jeffrey J.
Schwartz Law Firm, P.C.
SouthPark Towers
6100 Fairview Road, Suite 530
Charlotte, North Carolina 28210
US

to represent the undersigned before

[X] all the competent International Authorities
[ ] the International Searching Authority only
[ ] the International Preliminary Examining Authority only

in connection with the international application identified below:

Title of the invention: System and Method for Electronically Identifying Vehicle Wheels On-the-Fly During Manufacture

Applicant's or agent's file reference: 138/6PCT

International application number (if already available):

filed with the following Office US as receiving Office
and to make or receive payments on behalf of the undersigned.

Signature of the applicant(s) *(where there are several applicants, each of them must sign; next to each signature, indicate the name of the person signing and the capacity in which the person signs, if such capacity is not obvious from reading the request or this power)*:

Larry C. Smyth

Date: JULY 16, 2004

Form PCT/Model of power of attorney (for a given international application) (July 1992)

SYSTEM AND METHOD FOR ELECTRONICALLY IDENTIFYING VEHICLE WHEELS ON-THE-FLY DURING MANUFACTURE

Technical Field and Background of the Invention

The invention relates to a system and method for electronically identifying vehicle wheels on-the-fly during manufacture. The term "manufacture" is used broadly herein to include any sequential processing of the wheel prior to its actual mounting on a vehicle. In addition to vehicle wheels, the general concept of the present invention is applicable to any other item whose identification during or after manufacture is either necessary or desirable.

The manufacturing of cast alloy wheels is generally an ordered process of sequential events. Some of these events are specific to an exact wheel model, while others are not. For example, machining is geometry specific, and if the wrong casting is loaded, a dangerous and expensive crash occurs. Heat-treating, on the other hand is non-specific and the wheel model is not so important. However, as heat-treating is approximately an one shift process, it is still useful to know what is in the furnace for planning the subsequent operations. For reasons as diverse as these it is advantageous to identify wheels during manufacture.

The most common method to identify wheels is by a human operator. However, in higher volume automated operations, this is both expensive and less than 100% reliable. In these cases, sensor-based wheel model recognition systems are desired. Various sensor technologies are applicable, the most prevalent being machine vision. According to this technology, a snapshot of the wheel face is taken and compared against stored values. While this is relatively straightforward for a

human operator, it is a considerably more difficult task for machine vision, primarily because the snapshot is only a 2-D (two dimensional) image. Often such systems are only effective when used in parallel with other inputs, and in some cases, series snapshots are required to eliminate the probability of misidentification.

Another method used to identify wheel models is a combination of basic wheel measurements and basic profiling of the wheel face—see, for example, U.S. Patent 6,173,213 to Amiguet et al. This prior art method is used for the critical machining operation, and the profiling is performed by laser distance measurement scans at several concentric diameters. The method is relatively expensive, cannot differentiate wheels that share much common geometry, and takes too much time for inline model identification without the massive parallelism that occurs in wheel machining.

To help human operators readily distinguish between similar model wheels cast from different molds, the side cores are often engraved with mold numbers or letters. This is possible because the side cores form the rim periphery, an area of the wheel casting that invariably is 100% machined. While such lettering is readily seen in fluoroscopic images, and can be machine-recognized by optical character recognition (OCR), this technique is not a practical solution. Conventional machine vision is more realistic. However, the low contrast surface makes this a more difficult task.

The need for automated rapid identification of general products has led to information encoded on one-dimensional bar codes. These all-pervasive linear bar codes are typically high contrast marks, most often black bars on a white

background to facilitate reliable and rapid scanning and decoding. When low contrast bar codes are used, they are generally unreliable when read with conventional scanners. A solution for overcoming the low contrast issue is to use a particular type of 2-D bar code, where the bars are either below or above the general surface. By using more sophisticated scanners based on laser distance measurement units, these codes can be reliably read. This type of 2-D bar code is generally referred to as "bumpy bar code."

Given the relative ease of creating a bumpy bar code in manufactured parts, this model and mold number identification technique is now commonly practiced, thereby promoting the convenience and reliability of automated rapid identification. The technique is particularly common in automotive tire manufacturing, and more recently has been applied to cast wheels, where the bar code is formed in one side core. Bumpy bar code wheel model identification systems take advantage of the roundness of wheels. These systems have a reader station which centers the wheel casting in front of a laser point scanner, and then rotates the encoded rim to keep the background surface at an approximately constant depth. While the system is relatively fast and reliable, it is considerably expensive and inefficient because the conveyed wheel must be stopped at the reader station and then rotated up to 360 degrees in order to locate and scan the code.

Summary of Invention

Therefore, it is an object of the invention to provide a system and method for electronically identifying vehicle wheels on-the-fly during manufacture without slowing downstream forward movement of the wheel.

It is another object of the invention to provide a system and method which electronically locates and reads the wheel identification mark at the same time.

It is another object of the invention to provide a system and method for marking the vehicle wheel such that the wheel can be reliably machine-identified as it is conveyed into subsequent processes without stopping and rotating the wheel.

These and other objects of the present invention are achieved in the preferred embodiments disclosed below by providing a method for electronically identifying a vehicle wheel on-the-fly moving downstream from one processing location to another. The method includes the steps of locating a machine-readable identification mark applied to an exposed surface of the vehicle wheel. As the vehicle wheel moves downstream, the identification mark is electronically read on-the-fly.

According to another preferred embodiment of the invention, the method includes a first stage reading operation for locating the machine-readable identification mark on the moving vehicle wheel.

According to another preferred embodiment of the invention, the method includes a second stage reading operation downstream of the first stage reading operation for electronically reading the identification mark on the moving vehicle wheel.

According to another preferred embodiment of the invention, the second stage reading operation includes mounting multiple ID scanners at predetermined locations relative to the moving vehicle wheel.

According to another preferred embodiment of the invention, the second

stage reading operation includes mounting a single ID scanner at a predetermined location relative to the moving vehicle wheel.

According to another preferred embodiment of the invention, the method includes adjusting the location of the ID scanner relative to the moving vehicle wheel, such that the scanner intercepts the identification mark applied to the vehicle wheel.

According to another preferred embodiment of the invention, the method includes rotating the vehicle wheel between the first and second stage reading operations, such that the identification mark is oriented for interception by the ID scanner.

According to another preferred embodiment of the invention, the method includes locating at least one of multiple machine-readable identification marks applied to a circumference of the vehicle wheel.

According to another preferred embodiment of the invention, the vehicle wheel has at least three equally spaced, machine-readable identification marks.

According to another preferred embodiment of the invention, the identification marks are applied to a rim barrel of the vehicle wheel.

According to another preferred embodiment of the invention, the identification marks are applied to a rim flange of the vehicle wheel.

In another embodiment, the invention is a wheel identification system for electronically identifying a vehicle wheel on-the-fly moving downstream from one processing location to another. The system includes means for locating a machine-readable identification mark applied to an exposed surface of the vehicle wheel. At

least one ID scanner electronically reads the identification mark on-the-fly as the vehicle wheel moves downstream.

According to another preferred embodiment of the invention, the means for locating the identification mark includes a camera mounted upstream of the at least one ID scanner.

According to another preferred embodiment of the invention, the means for adjusting the location of said at least one ID scanner relative to the moving vehicle wheel, such that the ID scanner intercepts the identification mark applied to the vehicle wheel.

According to another preferred embodiment of the invention, means are located upstream of the at least one ID scanner for rotating the vehicle wheel, such that the identification mark is oriented for interception by the ID scanner.

According to another preferred embodiment of the invention, multiple ID scanners are mounted at predetermined locations relative to the moving vehicle wheel.

Brief Description of the Drawings

Some of the objects of the invention have been set forth above. Other objects and advantages of the invention will appear as the description proceeds when taken in conjunction with the following drawings, in which:

Figure 1 is a side view of a vehicle wheel carried on a powered roller conveyor, and showing a portion of the wheel in cross-section;

Figure 2 is a top view of the vehicle wheel on the powered roller conveyor;

Figure 3 is a side sectional view of the vehicle wheel in a first stage reading

operation for pre-identification of the wheel according to one preferred embodiment of the invention;

Figure 4 is a top view of the vehicle wheel after pre-identification and prior to a second stage reading operation;

Figure 5 is a top view of the vehicle wheel in an angular adjustment zone applicable for orienting the wheel for identification according to second embodiment of the invention;

Figure 6 is a side sectional view of the vehicle wheel in the first stage reading operation according to a third embodiment of the invention;

Figure 7 is a top view of the vehicle wheel after pre-identification and prior to the second stage reading operation;

Figure 8 is a top view of the vehicle wheel in a wheel identification zone comprising a number of strategically arranged scanners applicable for identifying the wheel according to a fourth embodiment of the present invention;

Figure 9 is a side sectional view of a vehicle wheel including a number of equally spaced identification marks applicable for identifying the wheel according to a fifth embodiment of the invention;

Figure 9A is an enlarged view of a portion of the inboard rim flange including the wheel identification mark;

Figure 10 is a top view of the vehicle wheel illustrating in phantom the circumferentially-spaced identification marks applied to the inboard rim flange;

Figure 11 is a side view of the vehicle wheel illustrating application of the identification marks to the rim barrel of the wheel; and

Figure 12 is a top view of the vehicle wheel showing the identification marks in phantom.

Description of the Preferred Embodiment and Best Mode

Referring now specifically to the drawings, Figures 1 and 2 illustrate a standard cast aluminum wheel 10 applicable for electronic identification according to a method of the present invention. The vehicle wheel 10 comprises an integrally-formed center hub 11, hub spokes 12, and wheel rim 14. The wheel rim 14 has an annular inboard flange 15, an opposing annular outboard flange 16, and a rim barrel 17. The hub spokes 12 and rim areas 14, 15, and 16 are especially suited for application of one or more machine-readable identification marks "M" containing useful information regarding the vehicle wheel 10. This information may include, for example, the serial number, wheel model, size, mold number, angular orientation, and the like.

The wheel 10 is generally processed after casting in a face-up position with the inboard flange 15 resting directly on a powered roller conveyor "C", as best shown in Figure 2. The conveyor transports the wheel 10 at speeds in excess of 1 fps. The present method includes locating the identification mark "M" on the wheel 10, and electronically reading the mark "M" on-the-fly as the wheel 10 moves downstream from one processing location to the next. Typical wheel processing includes deflashing (fettling), desprueing, fluoroscopic inspection, solution heat-treatment, quenching, aging heat-treatment, shot blasting, painting, machining, clear coating and final inspection.

The wheel identification mark is preferably a keyless bar code which is either

laser-formed or peened using a direct part marking (DPM) process. In one embodiment, the identification mark is a Data Matrix code. This mark codes data based on the position of black spots within a 2-D matrix on a light background. Each black element is the same dimension, and it is the position of the element that codes the data. In another embodiment, the mark is an embossed three-dimensional bar code which can be read by using differences in height, rather than contrast, to distinguish between bars and spaces using a special reader. Alternatively, controlled lighting can be used to enhance contrast for more conventional machine vision reading. This code is particularly useful where printed labels will not adhere, or would be otherwise destroyed by a hostile or abrasive environment. Other suitable machine-readable code includes PosiCode, Dot Code A, USD5, QR Code, UltraCode, and SuperCode.

The wheel identification mark is read by using either one or more laser line scanners, other appropriate non-contact distance readers, or by conventional fixed focus optical vision scanners operatively positioned adjacent the roller conveyor. Standard line of sight tracking systems require the wheel identification mark to be presented within the scanner's field of view. While several non-contact distance reading technologies are suitable, to get high resolution the distance variation of the mark to the scanner (depth of field, or DOF) must be kept within a relatively tight range—usually under 50mm. The field of view (FOV) of such high-resolution scanners is also relatively limited—in the sub 100mm range. The DOF and FOV of optical vision scanners are significantly less—especially the DOF. The wheel identification mark, which can be any size but is typically in the 10mm range, is

preferably read when perpendicular to and in the same plane as the scanner.

The scanner's required resolution is directly related to the density of the bar code. For example, the higher the density of the bar code, the higher the scanner's resolution has to be to read a symbol. Generally, the lower the density of the bar code, the farther away the scanner can be to read a symbol. To account for certain inherent limitations and inaccuracies, the newest laser scanners employ "fuzzy logic" technology. This technology applies artificial intelligence to reading poorly printed bar codes and is ideal for low-contrast, high density bar codes. Fuzzy logic offers the highest level of performance and best first-time read rate across a range of bar code qualities including harsh environments and rugged operating conditions. Other applicable scanner processing technologies include optical character recognition / intelligent character recognition readers (for OCR fonts).

The concept of the present method is to locate and read the wheel identification mark "M" on-the-fly during processing without slowing or stopping downstream forward movement of the vehicle wheel 10. The concept is achieved in the various embodiments discussed below. The vehicle wheel 10 and its several components will be referenced below using the numerals discussed above and indicated in Figures 1 and 2. In addition, for each of the various embodiments, the reference letters "M", "S", and "C" will be used generically to refer to the wheel identification marks, scanners, and roller conveyor, respectively.

Referring to the identification system illustrated in Figures 3 and 4, as the vehicle wheel 10 is moved downstream on the roller conveyor "C", an overhead camera 20 captures a digital image of the wheel 10 and electronically determines

its model type based on a comparison of stored information contained in a wheel model database. Motion sensors or other suitable means (not shown) are employed to activate the camera 20 at a precise location of the wheel 10. Based on the particular wheel model and using a reference point 21 on the face-side of the wheel 10, the information determined by the camera 20 is electronically assimilated to locate the wheel identification mark "M". The mark "M" is preferably consistently applied in an exact location relative to the reference point 21 for each of the various wheel models. In the present example, the identification mark "M" is formed with the underside of a hub spoke 12.

Once the location of the identification mark "M" is determined, the camera 20 transmits an adjustment signal to a downstream scanner "S". The signal automatically adjusts the scanner's DOF to that required for the particular wheel model, and effects sliding lateral movement of the scanner "S" along a cross-guide to properly arrange its FOV in precise vertical alignment with the location of the wheel identification mark "M". As the wheel 10 passes vertically over the scanner "S", the identification mark "M" is read by the scanner "S" and the wheel information relayed to downstream processing locations. The identification mark "M" is electronically read on-the-fly without slowing or stopping forward movement of the vehicle wheel 10.

As an alternative to the sliding scanner, discussed above, laterally-opposing angular adjustment belts 26 and 27 shown in Figure 5 may be employed to rotate the wheel 10 on-the-fly according to wheel model and orientation data transmitted by the camera 20. In this embodiment, the wheel 10 is rotated a precise degree

relative to a fixed scanner "S" in order to position the identification mark "M" within the scanner's FOV as the wheel 10 is conveyed past the scanner "S". The belts 26, 27 cooperate to adjust the orientation of the wheel 10 without stopping or slowing the roller conveyor "C".

A third embodiment of the present system is illustrated in Figures 6 and 7. The wheel identification mark "M" is applied to the underside of a hub spoke 12, as previously described. As the vehicle wheel 10 is moved downstream on the roller conveyor "C", an under-mounted distance measurement device "D" determines the exact distance between the device and the underside of the hub spoke 12. Motion sensors or other suitable means (not shown) are employed to activate the device "D". This distance measurement is then transmitted to a series of laterally-spaced scanners "S" having respective overlapping fields of view. Based on the transmitted distance, the DOF is automatically adjusted for each of the scanners "S". As the wheel 10 passes vertically over the scanners "S", the identification mark is electronically read by at least one of the scanners "S" and the wheel information relayed to downstream processing locations. The identification mark "M" is read by the scanner "S" on-the-fly without slowing or stopping forward movement of the vehicle wheel 10.

Figure 8 illustrates a fourth embodiment of the wheel identification system. According to this embodiment, the wheel identification mark "M" is applied to an outer surface of the rim barrel 17. While moving downstream on the roller conveyor "C", the wheel 10 enters an identification zone comprising a number of side-mounted strategically arranged scanners "S" operable for reading the entire outer

circumferential surface area of the wheel 10. The identification mark "M" is located and electronically read by at least one of the scanners "S" regardless of the wheel's orientation on the roller conveyor "C", and without slowing or stopping the wheel 10.

Figures 9, 9A and 10 illustrate application of the present method in a vehicle wheel 10 with eight identical, circumferentially-spaced identification marks "M" formed with its inboard flange 15. The identification marks "M" are equally spaced 45-degrees apart. As shown in Figure 9, the scanner "S" is under-mounted below the roller conveyor "C". As the wheel 10 moves past the scanner "S", at least one of the marks "M" is captured within the scanner's FOV. The scanner "S" reads the identification mark "M" without stopping or slowing forward movement of the vehicle wheel 10, and electronically relays this information to downstream processing locations.

This multiple mark concept is further illustrated in Figures 11 and 12. In this embodiment, eight identical, circumferentially-spaced identification marks "M" are applied to the rim barrel 17 of the vehicle wheel 10. The scanner "S" is mounted to the side of the roller conveyor "C". As the wheel 10 moves past the scanner "S", at least one of the marks "M" is captured within the scanner's FOV. The scanner "S" reads the identification mark "M" without stopping or slowing forward movement of the vehicle wheel 10, and electronically relays this information to downstream processing locations.

A further concept of the present method and system, discussed generally in reference to Figures 3 and 4, is the ability to determine the angular orientation of the wheel on-the-fly for purposes other than locating the identification mark. Knowing

the precise wheel orientation is especially critical during certain operations, such as lug hole drilling. In the embodiments of Figures 6-12, either multiple scanners and a single identification mark (Figures 6-8) or multiple identification marks and a single scanner (Figures 9-12) are used to automate wheel identification without stopping or slowing forward movement of the wheel. In the case of multiple scanners, general wheel orientation is determined by identifying which scanner locates the mark. For each of the various wheel models, the single identification mark is consistently applied in an exact location relative to a predetermined reference point on the wheel, such as the valve hole perch. In the case of multiple identification marks, wheel orientation is determination by identifying the location of the particular mark read by the scanner relative to the reference point on the wheel. Each mark includes a different code indicating its location relative to the reference point. For each of the various wheel models, the identification marks are consistently located an exact spaced-apart distance relative to each other, and relative to the reference point.

A method and system for electronically identifying a vehicle wheel on-the-fly during manufacture is described above. Various details of the invention may be changed without departing from its scope. Furthermore, the foregoing description of the preferred embodiment of the invention and best mode for practicing the invention are provided for the purpose of illustration only and not for the purpose of limitation—the invention being defined by the claims.

I Claim:

1. A method for electronically identifying a vehicle wheel on-the-fly moving downstream from one processing location to another, said method comprising the steps of:

(a) as the vehicle wheel moves downstream, locating a machine-readable identification mark applied to an exposed surface of the vehicle wheel; and

(b) electronically reading the identification mark on-the-fly.

2. A wheel identification method according to claim 1, and comprising a first stage reading operation for locating the machine-readable identification mark on the moving vehicle wheel.

3. A wheel identification method according to claim 2, and comprising a second stage reading operation downstream of said first stage reading operation for electronically reading the identification mark on the moving vehicle wheel.

4. A wheel identification method according to claim 3, wherein the second stage reading operation comprises mounting multiple ID scanners at predetermined locations relative to the moving vehicle wheel.

5. A wheel identification method according to claim 3, wherein the second stage reading operation comprises mounting a single ID scanner at a predetermined location relative to the moving vehicle wheel.

6. A wheel identification method according to claim 5, and comprising adjusting the location of the ID scanner relative to the moving vehicle wheel, such that the scanner intercepts the identification mark applied to the vehicle wheel.

7. A wheel identification method according to claim 3, and comprising rotating the vehicle wheel between the first and second stage reading operations, such that the identification mark is oriented for interception by the ID scanner.

8. A wheel identification method according to claim 1, and comprising locating at least one of multiple machine-readable identification marks applied to a circumference of the vehicle wheel.

9. A wheel identification method according to claim 8, wherein the vehicle wheel comprises at least three circumferentially-spaced, machine-readable identification marks.

10. A wheel identification method according to claim 9, wherein the identification marks are applied to a rim barrel of the vehicle wheel.

11. A wheel identification method according to claim 9, wherein the identification marks are applied to a rim flange of the vehicle wheel.

12. A wheel identification system for electronically identifying a vehicle wheel on-the-fly moving downstream from one processing location to another, said system comprising:

(a) means for locating a machine-readable identification mark applied to an exposed surface of the vehicle wheel; and

(b) at least one ID scanner for electronically reading the identification mark on-the-fly as the vehicle wheel moves downstream.

13. A wheel identification system according to claim 12, wherein said means for locating the identification mark comprises a camera mounted upstream of said at least one ID scanner.

14. A wheel identification system according to claim 12, and comprising means for adjusting the location of said at least one ID scanner relative to the moving vehicle wheel, such that said ID scanner intercepts the identification mark applied to the vehicle wheel.

15. A wheel identification system according to claim 12, and comprising means located upstream of said at least one ID scanner for rotating the vehicle wheel, such that the identification mark is oriented for interception by the ID scanner.

16. A wheel identification system according to claim 12, and comprising multiple ID scanners mounted at predetermined locations relative to the moving vehicle wheel.

Abstract of the Disclosure

The method electronically identifies a vehicle wheel on-the-fly moving downstream from one processing location to another. The method includes the steps of locating a machine-readable identification mark applied to an exposed surface of the vehicle wheel as the vehicle wheel. The identification mark is electronically read on-the-fly.

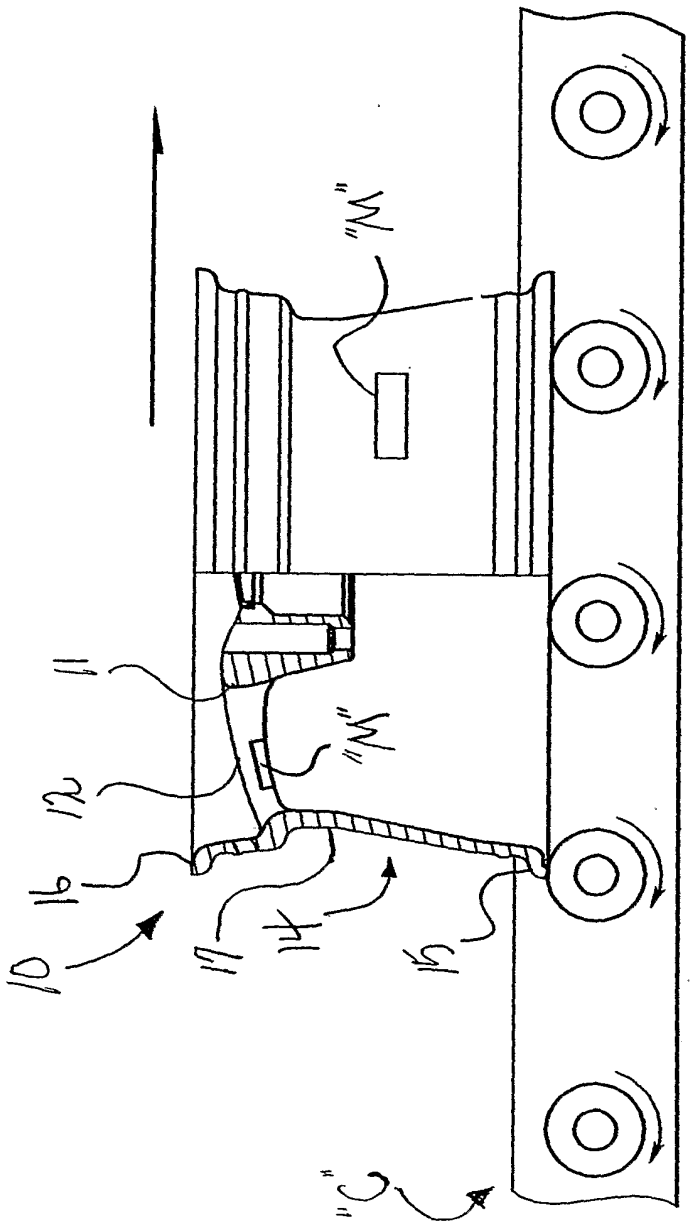

Fig. 1

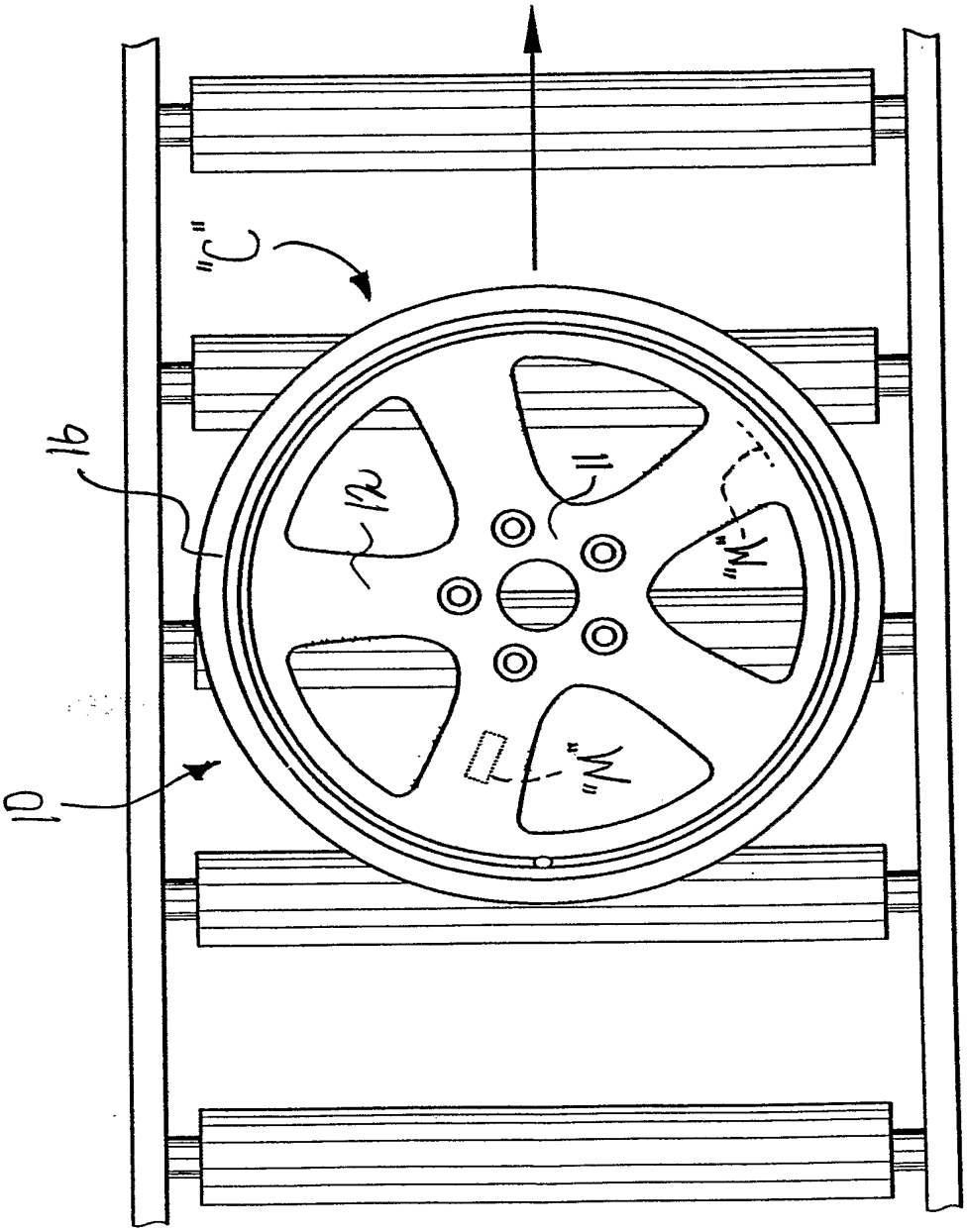

Fig. 2

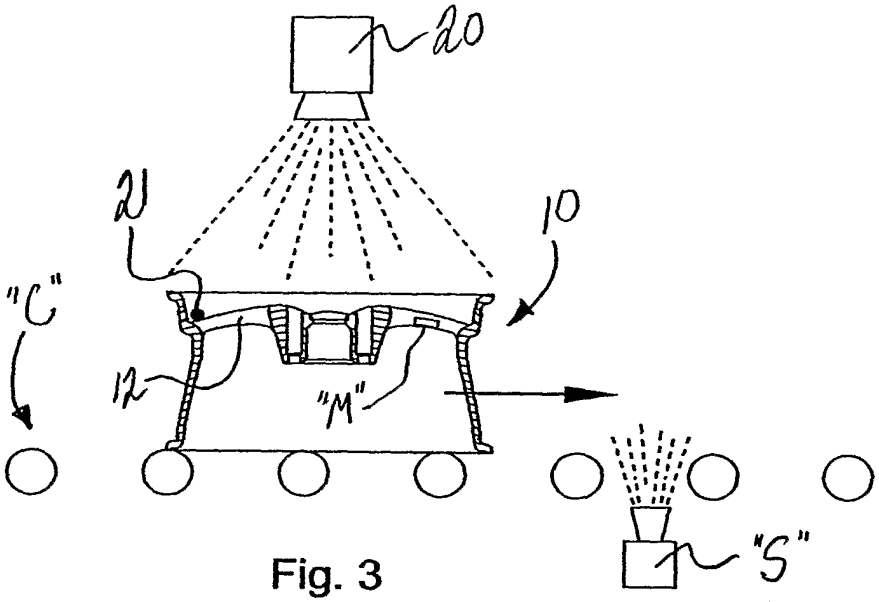

Fig. 3

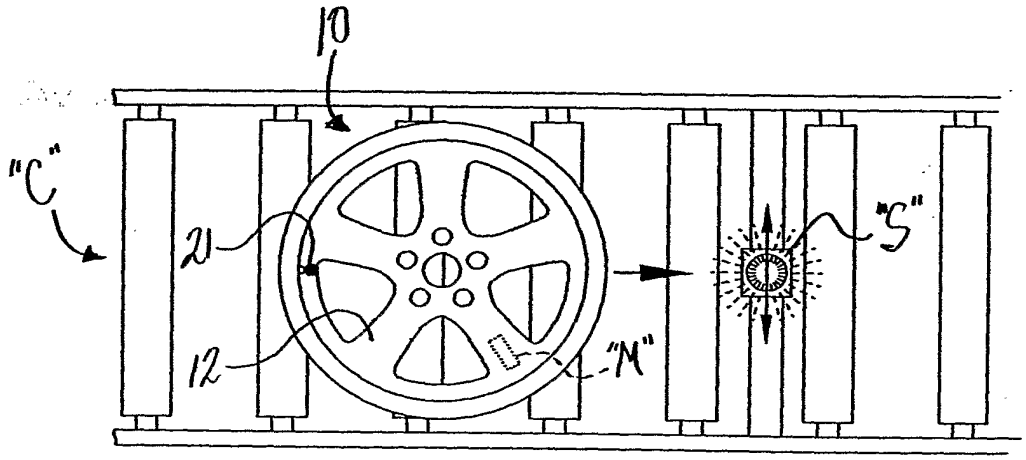

Fig. 4

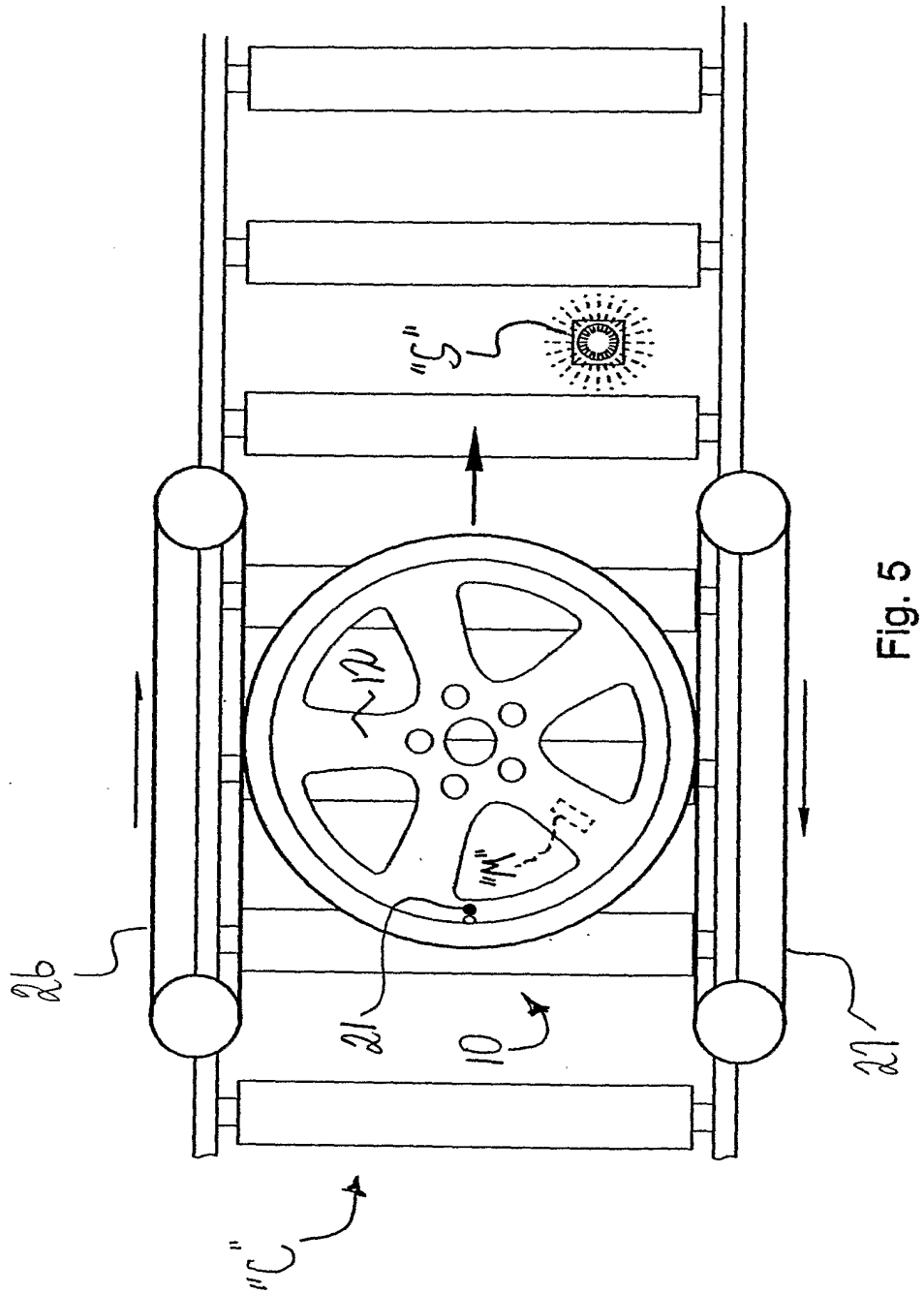

Fig. 5

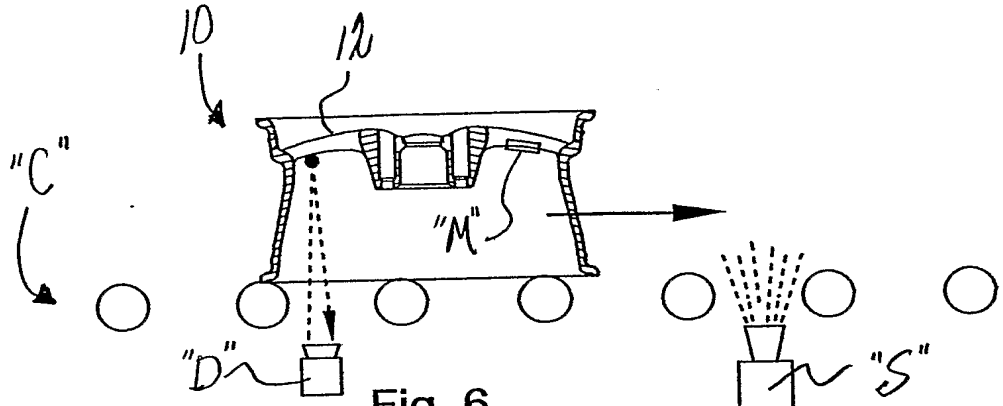

Fig. 6

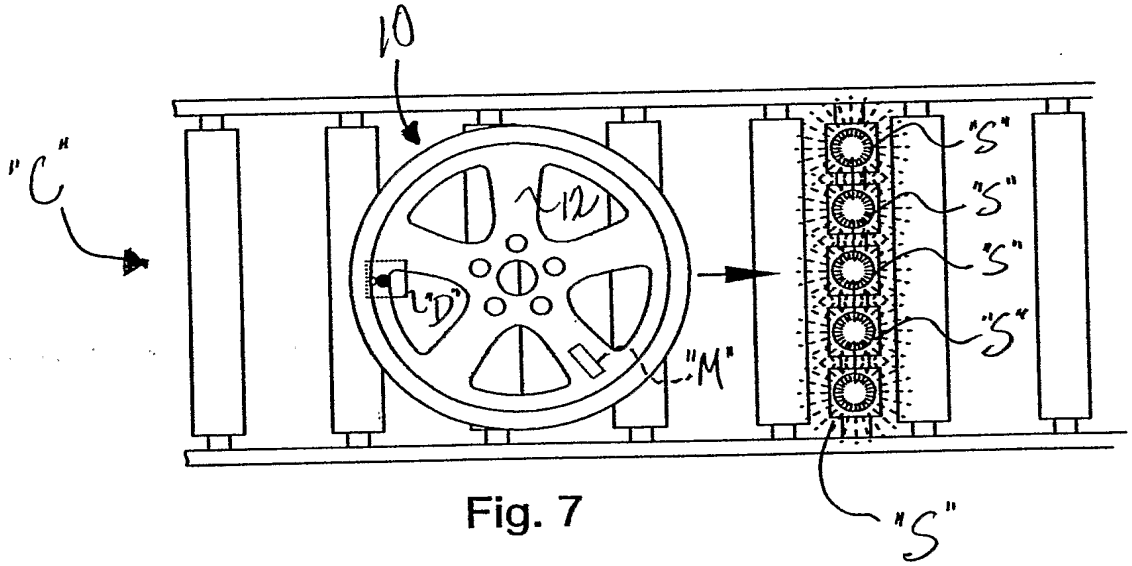

Fig. 7

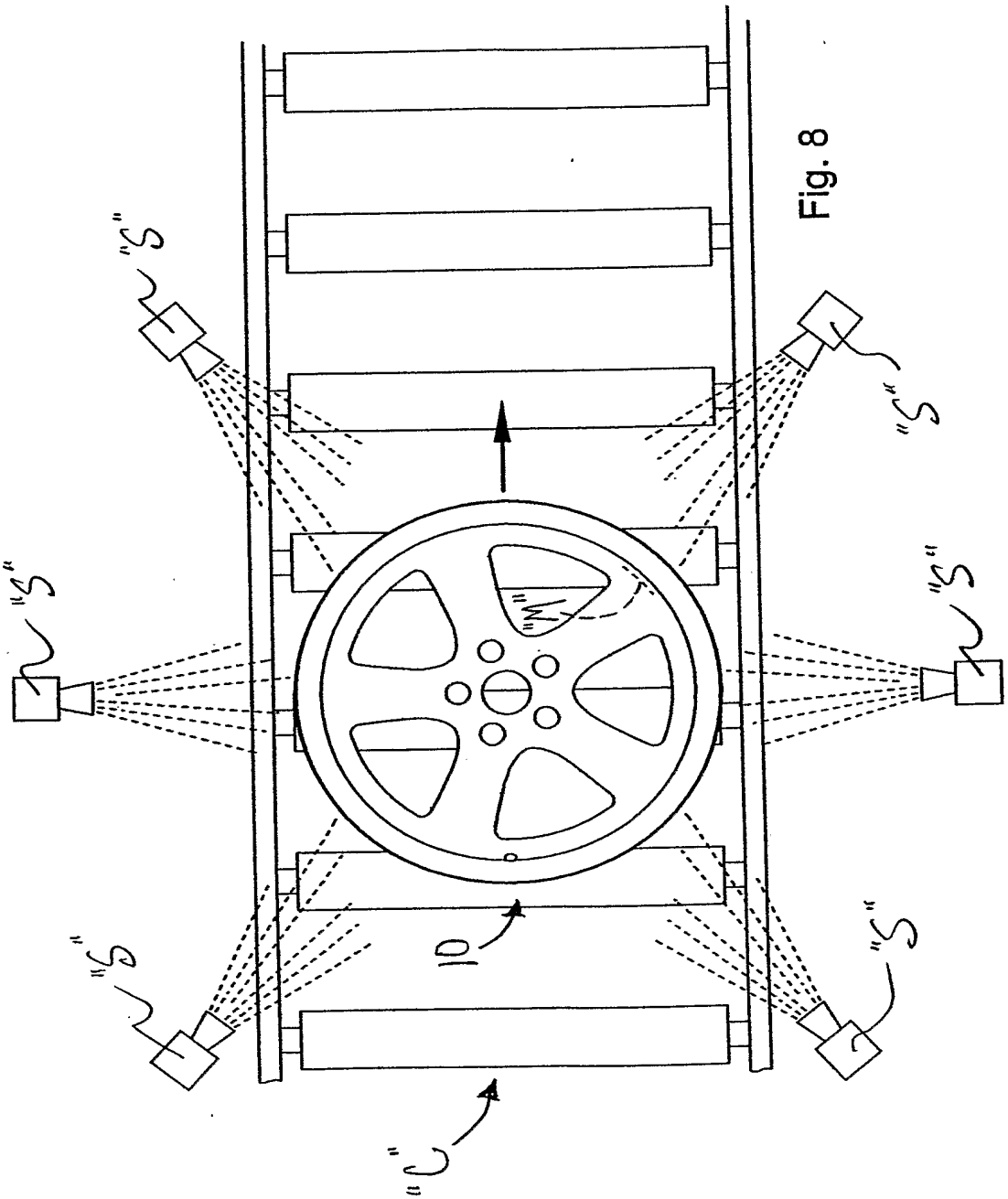

Fig. 8

Fig. 9A

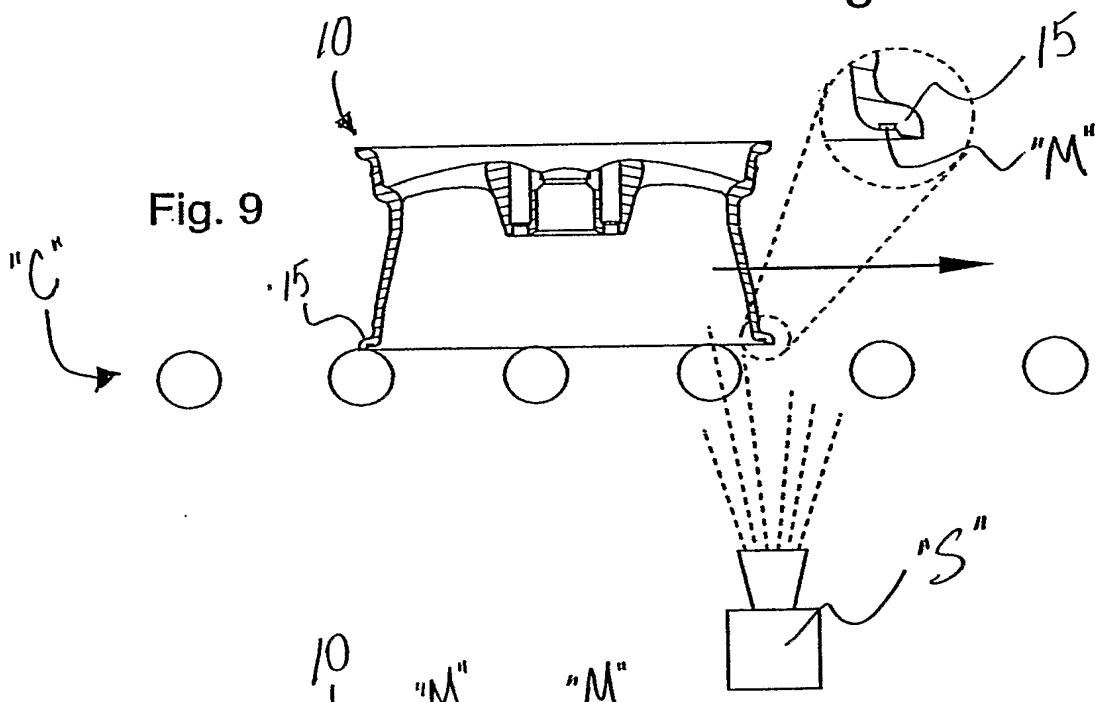

Fig. 9

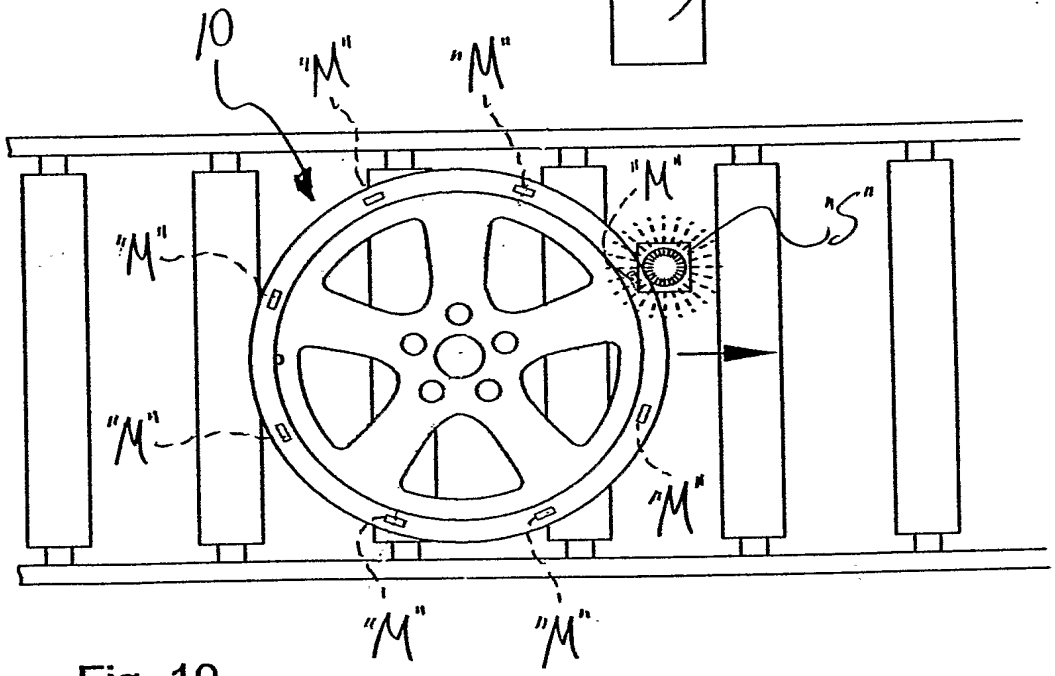

Fig. 10

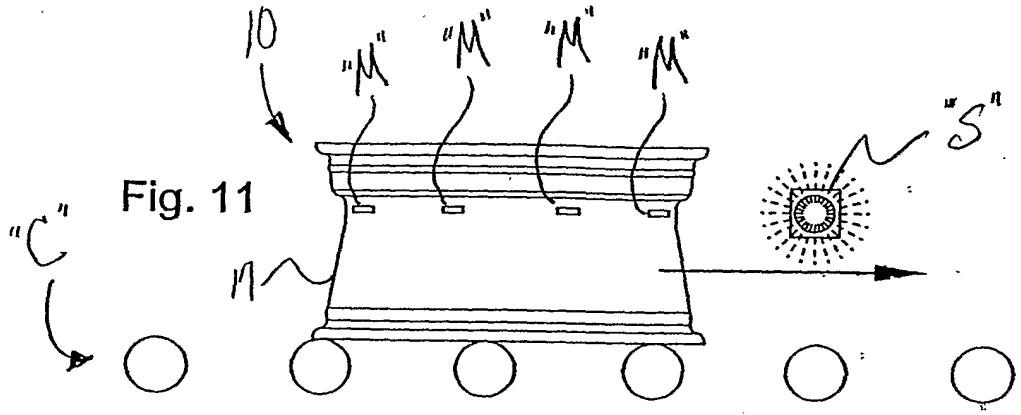

Fig. 11

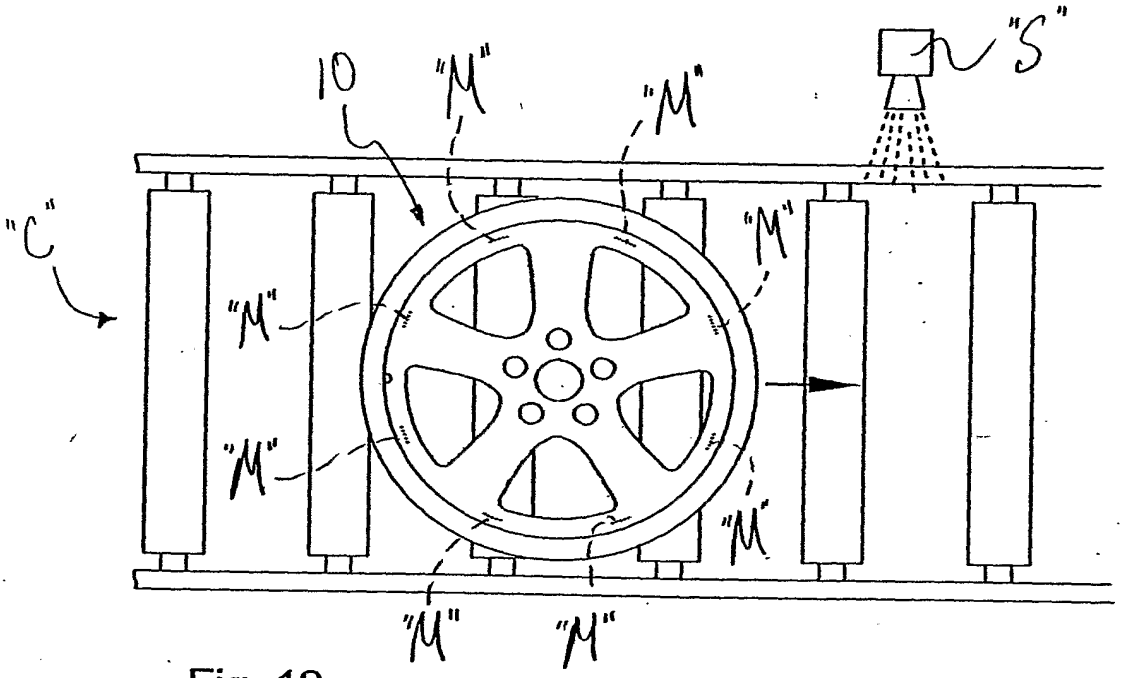

Fig. 12

PATENT COOPERATION TREATY

From the RECEIVING OFFICE

To:

JEFFREY J. SCHWARTZ
SCHWARTZ LAW FIRM, P.C
SOUTHPARK TOWERS
6100 FAIRVIEW ROAD, SUITE 530
CHARLOTTE, NORTH CAROLINA 28210

PCT

NOTIFICATION CONCERNING PAYMENT OF PRESCRIBED FEES

(PCT Rules 14, 15 and 16 and Administrative Instructions, Sections 102*bis*(c), 304, 323(b), 707(b) and 803)

Date of mailing *(day/month/year)*	02 Sep 2004
Applicant's or agent's file reference: 138/6PCT	**PAYMENT DUE** – see item 3 for time limits

International application No.	International filing date/Date of receipt *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2004/023133	19 Jul 2004	18 Jul 2003

Applicant: SMYTH, LARRY C

1. The applicant is hereby notified that this receiving Office has received:

☒ **the payment** of all the prescribed fees, and ☐ **an overpayment**, which will be refunded in due course.

☐ **no or insufficient payment** of the prescribed fees and the applicant is hereby **invited to pay the balance due**, as summarized under item 2, within the time limit(s) indicated under item 3.

2. **Fees and payment calculation:**

2,466.00	–	2,466.00	=	0.00
Total fees payable		Amount paid		Balance

☐ The details of the calculation are given in the Annex.

3. **Time limit(s) for payment and amount(s) payable (Rules 14.1, 15.4 and 16.1(f)):**

☐ within ONE MONTH from the date of receipt of the international application **(for the transmittal fee** (if any), **the search fee** and **the international filing fee)**. The amount payable for each fee is the amount applicable on the date of receipt of the international application.

☐ within 16 MONTHS from the priority date (only for the fee for priority document). The applicant's attention is drawn to the fact that the request made by the applicant under Rule 17.1(b) will be considered not to have been made unless the fee is paid within that time limit.

4. Additional observations *(if necessary)*:

☐ The search copy will not be transmitted to the International Searching Authority until the search fee is paid (therefore the start of the international search will be delayed) (Rule 23.1(a) and (b)).

Name and mailing address of the receiving Office	Authorized officer
Mail Stop PCT, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450	Darlene Proctor dP
Facsimile No. 703-305-3230	Telephone No. 703-305-3689

Form PCT/RO 102 (January 2004)

ANNEX TO FORM PCT/RO/102
CALCULATION OF THE PRESCRIBED FEES

International application No.
PCT/US2004/023133

[T] Transmittal Fee

Prescribed amount: . . . . . 300.00 [T]
Amount paid: . . . . . – 300.00
Balance: . . . . . = 0.00

[x] correct amount
[ ] overpayment
[ ] balance due

[S] Search Fee

Prescribed amount: . . . . . 1,000.00 [S]
Amount paid: . . . . . – 1,000.00
Balance: . . . . . = 0.00

[x] correct amount
[ ] overpayment
[ ] balance due

[I] International Filing Fee

Fixed amount for first 30 sheets: . . . . . 1,134.00 [i1]

1 (Number of sheets in excess of 30) x 12.00 (Fee per sheet) = 12.00 [i2]

Additional component: . . . 400 x 0.00 (Fee per sheet) = 0.00 [i3]

Reduction where the international application is filed *(See PCT Applicant's Guide, Volume I, General Part, for details on the availability of this reduction)*:

using the PCT-EASY software: . . . . . – 0.00 [r]
or
in electronic form where the text of the description, claims and abstract is **not** in character coded format: . . . . . – 0.00 [r]
or
in electronic form where the text of the description, claims and abstract is in character coded format: . . . . . – 0.00 [r]

Sub-total: . . . . . = 1,146.00 [i1+i2+i3-r]

Prescribed total amount *(The amount to be entered at I is the sub-total entered at (i1+i2+i3-r), except where the applicant is (or all applicants are) entitled to a reduction of 75%, in which case the amount to be entered at I is 25% of the sub-total (i1+i2+i3-r); certain applicants from certain States are entitled to a reduction of 75% of the international filing fee; see Notes to the Fee Calculation Sheet as annexed to the Request Form, PCT/RO/101, for details)*: . . . . . = 1,146.00 [I]
Amount paid: . . . . . – 1,146.00
Balance: . . . . . = 0.00

[x] correct amount
[ ] overpayment
[ ] balance due

[P] Fee for Priority Document

Prescribed amount: . . . . . 20.00 [P]
Amount paid: . . . . . – 20.00
Balance: . . . . . = 0.00

[x] correct amount
[ ] overpayment
[ ] balance due

PATENT COOPERATION TREATY

From the RECEIVING OFFICE

To:
JEFFREY J. SCHWARTZ
SCHWARTZ LAW FIRM, P.C
SOUTHPARK TOWERS
6100 FAIRVIEW ROAD, SUITE 530
CHARLOTTE, NORTH CAROLINA 28210

PCT

NOTIFICATION OF THE INTERNATIONAL APPLICATION NUMBER AND OF THE INTERNATIONAL FILING DATE

(PCT Rule 20.5(c))

Date of mailing *(day/month/year)*	02 Sep 2004
Applicant's or agent's file reference: 138/6PCT	**IMPORTANT NOTIFICATION**
International application No.: PCT/US2004/023133	International filing date *(day/month/year)*: 19 Jul 2004
Priority date *(day/month/year)*: 18 Jul 2003	
Applicant: SMYTH, LARRY C	
Title of the invention: SYSTEM AND METHOD FOR ELECTRONICALLY IDENTIFYING VEHICLE WHEELS ON-THE-FLY DURING MANUFACTURE	

1. The applicant is hereby notified that the international application has been accorded the international application number and the international filing date indicated above.

2. The applicant is further notified that the record copy of the international application:

[X] was transmitted to the International Bureau on 02 Sep 2004.

[ ] has not yet been transmitted to the International Bureau for the reason indicated below and a copy of this notification has been sent to the International Bureau*:

[ ] because the necessary national security clearance has not yet been obtained.

[ ] because *(reason to be specified)*:

* The International Bureau monitors the transmittal of the record copy by the receiving Office and will notify the applicant (with Form PCT/IB/301) of its receipt. Should the record copy not have been received by the expiration of 14 months from the priority date, the International Bureau will notify the applicant (Rule 22.1(c)).

3. FOREIGN TRANSMITTAL LICENSE INFORMATION — Completed by: DP

[ ] Additional license for foreign transmittal not required. This subject matter is covered by a license already granted or the equivalent U.S. national application. Refer to that license for information concerning its scope.

[ ] License for foreign transmittal not required. 37 CFR 5.11(e)(1) or 37 CFR 5.11(e)(2). However, a license may be required for additional subject matter. See 37 CFR 5.15(b).

[X] Foreign transmittal license granted. 35 U.S.C. 184; 37 CFR 5.11 on 28 Aug 2004 (date):

[X] 37 CFR 5.15(a) [ ] 37 CFR 5.15(b)

Name and mailing address of the receiving Office Mail Stop PCT, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 703-305-3230	Authorized officer Darlene Proctor Telephone No. 703-305-3689

Form PCT/RO/105 (July 1992)

PATENT COOPERATION TREATY

From the RECEIVING OFFICE

To:
JEFFREY J. SCHWARTZ
SCHWARTZ LAW FIRM, P.C
SOUTHPARK TOWERS
6100 FAIRVIEW ROAD, SUITE 530
CHARLOTTE, NORTH CAROLINA 28210

PCT

INVITATION TO CORRECT DEFECTS IN THE INTERNATIONAL APPLICATION

(PCT Articles 3(4)(i) and 14(1) and Rule 26)

Date of mailing *(day/month/year)*	02 Sep 2004
Applicant's or agent's file reference: 138/6PCT	**REPLY DUE** within 1 months/days from the above date of mailing
International application No.: PCT/US2004/023133	International filing date *(day/month/year)*: 19 Jul 2004
Applicant: SMYTH, LARRY C	

1. [X] The applicant is hereby **invited**, within the time limit indicated above, to correct, **in the international application as filed**, the defects specified on the attached:
   - [ ] Annex A
   - [ ] Annex B1 *(text matter of the international application as filed)*
   - [X] Annex C1 *(drawings of the international application as filed)*

2. [ ] The applicant is hereby **invited**, within the time limit indicated above, to correct, **in the translation of the international application** furnished under Rule 12.3 or 12.4, the defects specified on the attached:
   - [ ] Annex A
   - [ ] Annex B2 *(text matter of the translation of the international application)*
   - [ ] Annex C2 *(drawings of the translation of the international application)*

Additional observations (if necessary):

HOW TO CORRECT THE DEFECTS?

Correction must be submitted by filing a replacement sheet embodying the correction and a letter accompanying the replacement sheet, which shall draw attention to the difference between the replaced sheet and the replacement sheet. A correction may be stated in a letter only if it is of such a nature that it can be transferred from the letter to the record copy without adversely affecting the clarity and direct reproducibility of the sheet onto which the correction is to be transferred (Rule 26.4).

ATTENTION

Failure to correct the defects will result in the international application being considered withdrawn by this receiving Office (see Rule 26.5 for further details).

A copy of this invitation and any attachments has been sent to the International Bureau
[X] and the International Searching Authority

Name and mailing address of the receiving Office Mail Stop PCT, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 703-305-3230	Authorized officer Darlene Proctor dp Telephone No. 703-305-3689

Form PCT/RO/106 (January 2004)

ANNEX C1 TO FORM PCT/RO/106

International application No.
PCT/US2004/023133

This receiving Office has found that, with regard to the presentation of the **drawings of the international application as filed**, the physical requirements are not complied with to the extent that compliance therewith is necessary for:

1. [X] reasonably uniform international publication (Rules 11 and 26.3(a)(i)) *(defects to be specified)*:

Sheets containing drawings:

a. [ ] the sheets do not admit of direct reproduction
b. [ ] the sheets are not free from creases, cracks, folds
c. [ ] one side of the sheets is not left unused
d. [ ] the paper of the sheets is not flexible/strong/white/smooth/non-shiny/durable
e. [ ] the drawings do not commence on a new sheet
f. [ ] the sheets are not connected as prescribed (Rule 11.4(b))
g. [ ] the sheets are not A4 size (29.7cm x 21cm)
h. [ ] the minimum margins on the sheets are not as prescribed (top: 2.5cm; left side: 2.5cm; right side: 1.5cm; bottom: 1cm)
i. [ ] the file reference number indicated on the sheets does not appear in the left-hand corner of the sheets, within 1.5 cm of the top of the sheets
j. [ ] the file reference number exceeds the maximum of 12 characters
k. [ ] the sheets are not free from frames around usable or used surfaces
l. [X] the sheets are not numbered in consecutive Arabic numerals (e.g. 1/3, 2/3, 3/3)
m. [ ] the sheet numbers are not centered at the top or bottom of the sheets
n. [ ] the sheet numbers are in the margin (see h. above for the size of the margins)
o. [ ] the sheets contain alterations/overwritings/interlineations/too many erasures
p. [ ] the sheets contain photocopy marks

Drawings (Rule 11.13):

a. [ ] do not admit of direct reproduction
b. [ ] contain unnecessary text matter
c. [ ] contain words so placed as to prevent translation without interference with lines thereof
d. [ ] are not executed in durable black color; the lines are not uniformly thick and well-defined
e. [ ] contain cross-sections not properly hatched
f. [ ] would not be properly distinguishable in reduced reproduction
g. [ ] contain scales not represented graphically
h. [ ] contain numbers, letters and reference lines lacking simplicity and clarity
i. [ ] contain lines drafted without the aid of drafting instruments
j. [ ] contain disproportionate elements of a figure not necessary for clarity
k. [ ] contain numbers and letters of height less than 0.32 cm
l. [ ] contain letters not conforming to the Latin, and where customary, Greek alphabets
m. [ ] contain figures on two or more sheets which form a single complete figure but which are not able to be assembled without concealing parts thereof
n. [ ] contain figures which are not properly arranged and clearly separated
o. [ ] contain different figures not numbered in consecutive Arabic numerals
p. [ ] contain different figures not numbered independently of the numbering of the sheets
q. [ ] are not restricted to reference signs mentioned in the description
r. [ ] do not contain reference signs that are mentioned in the description
s. [ ] contain the same feature denoted by different reference signs
t. [ ] are not arranged in an upright position, clearly separated from one another
u. [ ] are not presented sideways with the top of the figures at the left side of the sheets

2. [ ] satisfactory reproduction (Rules 11 and 26.3(b)(i))

Further observations (if necessary):

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:

JEFFREY J. SCHWARTZ
SCHWARTZ LAW FIRM, P.C
SOUTHPARK TOWERS
6100 FAIRVIEW ROAD, SUITE 530
CHARLOTTE, NORTH CAROLINA 28210

PCT

NOTIFICATION OF RECEIPT
OF SEARCH COPY

(PCT Rule 25.1)

Date of mailing *(day/month/year)*	02 Sep 2004
Applicant's or agent's file reference: 138/6PCT	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2004/023133	19 Jul 2004	18 Jul 2003

Applicant

SMYTH, LARRY C

1. **Where the International Searching Authority and the receiving Office are not the same Office:**
The applicant is hereby notified that the search copy of the international application was received by this International Searching Authority on the date indicated below.

Where the International Searching Authority and the receiving Office are the same Office:
The applicant is hereby notified that the search copy of the international application was received on the date indicated below.

02 Sep 2004 *(date of receipt).*

2. ☐ The search copy was accompanied by a nucleotide and/or amino acid sequence listing or tables related thereto in computer readable form.

3. **Time limit for establishment of international search report and written opinion of the International Searching Authority**
The applicant is informed that the time limit for establishing the international search report and the written opinion of the International Searching Authority is three months from the date of receipt indicated above or nine months from the priority date, whichever time limit expires later (Rules 42.1 and 43*bis*.1(a)).

4. A copy of this notification has been sent to the International Bureau and, where the first sentence of paragraph 1 applies, to the receiving Office.

Name and mailing address of the ISA/	Authorized officer
Mail Stop PCT, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450	Darlene Proctor dp
Facsimile No. 703-305-3230	Telephone No. 703-305-3689

Form PCT/ISA/202 (January 2004)